

Application of an Integrated Monitoring and Modeling System to Narragansett Bay and Adjacent Waters incorporating Internet-Based-Technology

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LONG-TERM GOALS

The long term goal of this initiative is to develop a globally re-locatable, integrated system for real time observation, modeling, and data distribution for shelf, coastal sea, and estuarine waters. The models would be forced by input from Global Ocean Data Assimilation Experiment (GODAE) products or similar global or shelf scale modeling systems. It is proposed to apply the system to Narragansett Bay and RI coastal waters as a demonstration of the practical use of the system to support environmental monitoring, marine pollutant transport and fate, marine transportation, and search and rescue operations and to provide a foundation to advance our understanding and predictive capabilities for the bay. The final goal is to transition this system to the commercial marketplace and broaden the sources of support for the continued development and wide spread application of the system.

OBJECTIVES

The specific objectives of the initiative are:

1. To develop and implement an operational three-dimensional hydrodynamic and pollutant transport model, with data assimilation, for Narragansett Bay and adjacent Rhode Island coastal waters. The application will demonstrate the ability of the models to provide hindcasts, nowcasts, and forecasts and maximize the timely and effective use of GODAE data products. The model will use GODAE data products for forcing on the open boundary and hence extend this data to coastal and estuarine waters.
2. To coordinate the collection, dissemination and archiving of observed sea surface elevation, water quality, meteorological, and current and water transport data from a network of monitoring stations in Narragansett Bay and adjoining waters including global ocean data products generated through the GODAE initiative and other sources. This objective will be accomplished through the development of a platform independent internet based data and model product data distribution system that will allow industry, researchers, government, and public to conveniently access all relevant data from the local monitoring system, GODAE and all model simulation results.
3. To assess the market for the GODAE, high resolution coastal model, and observational data products and services for Narragansett Bay and to determine the most efficient and cost effective mechanisms to distribute the data to the clients and user community.
4. To transfer the technology and software for the system to private industry as a basis to develop a commercial market for a globally re-locatable, fully operational monitoring, modeling and data distribution system. The technology transfer is intended to establish a commercial basis so that data products generated by GODAE and similar initiatives can be marketed on a global basis.

APPROACH AND WORK PLAN

The work is being performed by a team of investigators from academia, government and industry. Presented below is a summary of the work elements and team members and their affiliations performing each work element.

- Narragansett Bay data collection, management, and distribution system and COASTMAP development, M. Spaulding and T. Opishinski, Ocean Engineering, University of RI

- Remote thermal imagery of Narragansett Bay, Jack Mustard, Brown University
- Real time meteorological now/forecasting, John Kelley and Marina Tsidulko, NOAA/NOS
- Real time hydrodynamic modeling with data assimilation, M. Ward and C. Swanson, Applied Science Associates, Inc.
- Internet data and model product data distribution system, M. Piasecki, Drexel University

WORK COMPLETED

University of Rhode Island Ocean Engineering

Development and testing of the data acquisition and management server was completed during the final year of the project. The data server, operating in Windows 2000, has the ability to acquire environmental data from internet sites and subsequently process, archive and distribute the data to support associated clients, including COASTMAP and Drexel's web based distribution system, IM², Fig 1. The system includes an integrated management system to configure the operation of the system and a status display to monitor data acquisition and export processes. The system's asynchronous architecture supports multiple simultaneous Internet connects to permit time acquisition, processing and distribution of data. The system was thoroughly tested by application to Narragansett Bay and supported acquisition and distribution of NOAA PORTS, Brown satellite thermal imagery, and meteorological and hydrodynamic model forecasts. The system has been documented in a final report (Opishinksi and Spaulding, 2003).

A Users Demonstration and Training Workshop was held in the Coastal Institute Building, Hazard Rooms A and B, April 22, 2003, 9 AM to 4 PM. The goals of the workshop were (1) to provide a demonstration of the system and its practical applications to potential system users and (2) to provide training in the use of the system to the user community. Thirty three (33) individuals participated in the workshop, which had twelve (12) presenters. The invited participants included representatives from all the major potential user groups including: USCG and Navy personnel, environmental regulators, government and academic researchers, water quality managers, recreational boaters, state legislature representatives, education and outreach specialists, private industry, harbor masters, environmental policy specialists, and non profit organizations. The morning session of the workshop featured presentations of the NOPP project and its application to Narragansett Bay. The afternoon session was devoted to hands on training in COASTMAP and the two web based systems operated by NOAA/NOS and Drexel's IM² system. The workshop was followed by two formal evaluation periods, consisting of two demonstration periods, May 5 to 16, 2003 and July 14 to 25, 2003. The break between the first and second evaluation periods was used to modify the system output to address comments made during the first evaluation period.

Drexel University

The web-based data information system IM2 (Fig. 2) has been further refined and upgraded during the past year. Most of this upgrading work has been based on the result of the Users Demonstration and Training Workshop on April 22, 2003, held at the Narragansett Bay campus of URI. During this workshop users were given the opportunity to access and test the IM2 system online and then fill out a survey page to express their opinion about the IM2 system. Questions asked concerned the ease of use, navigation, clarity of design and labeling, level of functionality, level of data products presented, completeness of information, accuracy of data display options, and selection of appropriate default

values. The users were also asked to supply suggestions for improvement in all categories, which yielded a rich pool of potential improvements to be considered for implementation.

While the overall response to the system was very positive, indicating that the results of the survey conducted at the beginning of the project had been well responded to during the design period of the system, several suggestions were made to improve the system. Among the suggestions were the inclusion of optional unit systems, different color coding of the legends, inclusion of color coding and length scales for displaying vector quantities (flow field of ocean surface layer) and the change of wind vector display from vector heads to wind banes, a display convention that is commonly in the atmospheric sciences community (see Fig. 3). All of these changes have been incorporated into the IM2 system. Finally, several updates were made to the automatic data collection/receiving system of the NOPP and IM2 servers to provide a higher level of fail safe and increased operational stability. The system has been online since the completion of the upgrades without disruption.

Applied Science Associates, Inc.

Applied Science Associates (ASA) has continued to commercially develop COASTMAP, especially in the areas of National Security and Search and Rescue Operations. COASTMAP is currently integrated into the US Naval Oceanographic Offices long term model development and response modeling infrastructures with a total of 4 licenses currently in place and plans for further expansion in FY05. Further details are given in the National Security section (below). ASA will also be leveraging the COASTMAP architecture in support of the development of the US Coast Guards next generation Search and Rescue system, further details below, and has opened discussions with the US Navy to develop a similar system for military applications. ASA has also continued its public outreach efforts by participating in user workshops and presenting at national/international conferences and to potential local users groups, details of the presentations and publications are detailed below.

NOAA National Ocean Service

Drs. John G. W. Kelley and Marina Tsidulko with NOAA's National Ocean Service (NOS) Marine Modeling and Analysis Programs in Silver Spring, MD has implemented NOAA/Forecast System Laboratory's Local Analysis and Prediction System (LAPS) for Narragansett Bay and adjacent coastal water to provide near real-time, high-resolution (4km) hourly atmospheric analyses for use by the ASA, Inc.'s real-time, numerical estuarine forecast system. LAPS uses observations from traditional observing platforms as well as mesonets. In order to provide hourly atmospheric forecasts for the forecast cycle of the estuarine model, NOS has also implemented a non-hydrostatic, workstation version of the NWS/National Centers for Environmental Prediction's Eta weather prediction model to produce high-resolution (4 km) hourly forecasts out to 24 hours once per day for the same region. It was discovered had a serious cold bias on surface nighttime air temperature forecasts. Therefore, the workstation Eta model was replaced with the Penn State/NCAR mesoscale atmospheric forecast model (MM5) during the late Winter 2003. The MM5 was configured using a single grid domain consisting of 82 x 102 grid points with a horizontal resolution of 4 km with 37 vertical sigma levels. The lateral boundary conditions and initial conditions were obtained from the forecasts of NCEP's operational Eta-12 km model. Sea surface temperatures (SSTs) for the coastal ocean and estuaries were based on NCEP's daily, real-time global SST analysis. The LAPS analyses and MM5 forecasts were made available in netCDF on a NOS ftp server and also displayed on NOS web page at <http://chartmaker.ncd.noaa.gov/csdl/op/aboutNBLAPS.html>.

Brown University

Dr. John Mustard at Brown University did not have any funds allotted during 2003.

RESULTS

Drexel University has received on a regular basis forecast data for the Narragansett Bay and adjacent waters from ASA's BFShydro numerical hydrodynamic simulation model, which provided water elevation and surface velocity fields for 24 hour forecast on an hourly basis. This data, together with sensor data from the PORTS and other programs, was delivered through a "push" setup, i.e. ASA and URI's coastmap server sent their data to Drexel's NOPP server, where it was processed and stored for use by the IM2 system. A secondary server has been pulling data from NOAA's coastal survey lab server, which held NBMM5 forecast data (also 24 hours out on an hourly interval) for Air and Dew Point Temperature, Sea Level Air Pressure, Precipitation and Wind Velocities in netCDF format. As a result, Drexel had to extend its data handler capability by including an automated pull and subsequent decoding of netCDF data.

The increased involvement and hardware items made it necessary to streamline the communications between the three involved servers, including continuous upgrade of the different operating systems (LINUX, SOLARIS) as well the installation of a security monitoring device to prevent unauthorized access to the powerful servers. The IM2 system continues to be fully operational without any interruptions, even though the data flow has subsided in the past months, due to the project end for ASA (loss of the hydrodynamic forecast data) and the end of the NOAA MM5 data supply earlier this year, which leaves only the real-time data sent by URI's coastmap-server.

The principal results from the URI and ASA study are

- COASTMAP system is fully developed and operational for Narragansett Bay.
- Based on early efforts, COASTMAP has demonstrated significant potential in the market place, either as a stand-alone system for a given user or as part of a larger system.
- Ease of application of the system to other geographic areas and the scalability from small (estuary or bay) to larger areas (coastal waters of a given country) have been demonstrated.
- The user demonstration and training workshop has clearly demonstrated the need to take particular care in structuring the system operation and products to meet the user's needs. Our strategy of providing access to the larger user community via web browser and to the professional user via a personal computer has met with good acceptance from both communities.

The workstation Eta model surface forecasts of air temperature and wind velocity have been compared to observations for selected inland and coastal stations in the Narragansett Bay region for a 2 week period in July 2002. The limited evaluation indicated a relatively good agreement between forecasts and observations. Land-sea differences are well described although in some synoptic situations the predicted values may not match the observations. Also, in comparison with NCEP's operational 12 km Eta model, it was found that 4km resolution model better describes temperature and wind in coastal zone, whereas the models demonstrates almost the same forecast over in land areas. In addition, qualitative evaluation of the Eta model's air temperature and dew point temperature forecasts during autumn of 2002 and first part of the winter of 2003 has shown a large negative bias over land. NOS

has informed NCEP about this serious problem and is working with them to identify the source of the problem and solve it. Because of this serious problem, the workstation Eta was replaced by MM5 for the remaining months of the project. Since MM5 replaced the workstation Eta model late in the project, an extensive evaluation of MM5 surface forecasts for the region has not yet been conducted. However, a non-quantitative comparisons were performed for a few sea breeze events. The comparisons indicate that MM5 failed to properly forecast the bay breeze in Narragansett Bay. A quantitative evaluation of MM5 forecasts will be conducted for the sea breeze event of 19 May. MM5 will be evaluated using observations from traditional observing systems as well as mesonets operated by state and federal agencies and local universities.

IMPACT AND APPLICATIONS

National Security

As evidenced by the numerous applications in the general area of national security, as presented in the Transitions section below, COASTMAP appears to have a very bright future. It is likely that some applications will use COASTMAP as a stand-alone system, while others will link COASTMAP to other model systems (Crisis Management Systems(oil and chemical spill, nuclear fall out, atmospheric release of biological agents), search and rescue, Incident Command Systems, etc.). Experience to date suggests that some of main building blocks in COASTMAP can readily be used in developing other coastal and land based information support systems.

The project has led to an improvement in LAPS' surface analyses. These improvements were incorporated by LAPS development team at NOAA's Forecast System Laboratory in the latest version of LAPS. LAPS is used by the NWS nationwide and also by the U.S. Air Force. In addition, LAPS is also used by NOS to produce analyses over Chesapeake Bay including the Washington, DC metro area. The gridded analyses for both Narragansett and Chesapeake Bays were sent hourly during 2003 to the Defense Department's Defense Threat Reduction Agency for potential use in their air dispersion trajectory models in support of Homeland Defense. The project also demonstrated that the workstation version of the Eta model has a serious cold nighttime bias in its air temperature forecasts which limits the usefulness of its guidance to weather forecasters.

Scientific Research

Drexel University is in the process of submitting a proposal to the National Science Foundation (NSF) to develop a Seismic Array Data Information System to make seismic array data accessible to earthquake engineering applications, particularly to bridge engineering. One part of the proposal concerns the development of a community specific metadata set that requires the blending of community specific data description conventions, the adaptation of general data description conventions (international metadata standards), as well as the inclusion of the Web Ontology Language (OWL). Lessons learned from the IM2 system have an important impact on the proposed development of the community specific metadata set. Also, the modularity of the IM2 system permits a straight forward adaptation to the Seismic Array Data system, from which it will be used. In addition, the project team is proposing to incorporate this adapted system into the George E. Brown Network for

Earthquake Engineering Simulation (NEES) to become an integral of the NEESGrid information system.

Drexel University has also received funding to develop a metadata set for the hydrologic community, which will draw from the experiences to use the Dublin Core Metadata set in this project. The proposed use of international metadata standard together with the use of the OWL have the potential to overcome the widespread lack of interoperability of data descriptions, which has also been one of the key difficulties to overcome during this project. In addition, Drexel University has received much recognition from NSF for the expertise gained from this project, which has resulted in invitations to partake in NSF's Engineering Cyberinfrastructure initiative as expert and workshop host. This also includes the active participation in the Collaborative Large-scale Engineering Analysis Network for Environmental Research (CLEANER) initiative, for which Drexel was encouraged to submit a planning grant seeking to assess the cyberinfrastructure needs of an environmental field facility.

The University of Rhode Island, Ocean Engineering Department is currently working with other New England land grant institutions to assemble a team of university, government and private industry researchers to respond to an anticipated BAA from the Department of Homeland Security (DHS) for establishing of an academically based Center of Excellence. URI has been designated to take the lead in the harbor and port maritime security and response area for the consortium. The consortium currently includes Raytheon, General Dynamics/Electric Boat, L-3 Communications, Naval Underwater Warfare Center, Marine Ocean Technology Network, RI Economic Development Corp., McLaughlin Research Group, Vibtech, Sonic Works, FarSounder, and Klein Associates. It is anticipated that the request for white papers for the Center of Excellence in Emergency Response and Preparedness will be issued in Spring 2004. An initial version of the white paper has been drafted in the form of a vision statement for the development and application of a crisis management system for Narragansett Bay. One of the core components of the system will be COASTMAP, which will provide the supporting environmental data used as input to the crisis management system.

Economic Development

It is clear from the success that ASA has enjoyed to date (see Transition section) that there is a viable market for the COASTMAP system and its components. The system has already been applied to all US coastal waters by the Navy and components of it will be used in the next generation of US Coast Guard Search and Rescue planning systems. The system has also seen use in support of monitoring of coastal waters for assessing environmental impact associated with wastewater discharges. The integrated, systems based approach inherent in COASTMAP's architecture and its use of the internet for data acquisition and distribution will likely be the core of future crisis management and response systems for marine waters and nearby coastal lands.

Science Education and Communication

The development of the IM2 system has fostered the training of a new breed of scientists/engineers, which has been noted by NSF as a "needed expertise currently short in supply". The graduate students involved in the development of IM2 have a background in coastal and hydrology engineering, with an initially only a passing knowledge base in computer science and information science technology. Through this project they had the opportunity to seek cross-disciplinary education by becoming proficient in technologies that are typically outside coastal and hydrology engineering fields, i.e. they

became knowledgeable in the use of web-based technologies like JAVA, XML, RDF, OWL, and also developed substantial operation system administrator skills that enabled them to fully implement and maintain the IM2 system on different computing platforms. In short, this project has given them the opportunity to become experts in an area halfway between engineering and computer science for which the cyberinfrastructure community has identified a growing future need. In

COASTMAP is proving to be a useful tool to communicate with state and federal agencies, private contractors, and the public. For example, the ability to display and animate model results detailing impacts of various port design options for Quonset Point provides a direct means to educate concerned parties and the public. Graphic representation of data and model results within a GIS framework, much like the presentation of weather reports, is easily comprehended.

The system can also be used as a tool to connect the classroom with marine waters. Since data can be displayed real time it will be possible to view what conditions are presently occurring in the bay relative to circulation and water quality. A web-based system allows any number of educational uses both in schools and by the public. This opportunity needs to be explored in greater depth.

TRANSITIONS

National Security

The US Naval Oceanographic Office's (NAVOCEANO) acquired additional licenses to COASTMAP (total of 4 to date) during the reporting year. They are using the system for environmental data collection and analysis and to support their operational forecasting/modeling systems. The data collected by the system are used to develop initial conditions and environmental forcing for operational coastal models to support homeland security activities within US waters and coastal warfare activities outside of the US. Environmental data which includes water level, river stream flow, meteorological, currents and temperature, is actively being collected, managed and analyzed from seven bays and harbors (Kings Bay, GA, Mayport, FL, San Diego, CA, Norfolk, VA, San Francisco, CA, Puget Sound, WA, and Charleston, SC) within the continental United States. Data from various regions around the world, including the US East and West Coasts, the Gulf of Mexico, the Great Lakes, the Yellow Sea and the Persian Gulf, are also being actively collected and analyzed. The total numbers of sensors, worldwide, is currently 275. These data are being used in the development of local forecasting models, similar to that being developed for Narragansett Bay under this project, as well as the Navy's regional operational models. The outputs from these hydrodynamic models are to be linked through the COASTMAP system with meteorological forecasts/data for use with constituent transport models, also linked with COASTMAP, in support of operational planning and action for special warfare, coastal insertion of ground forces, response to potential terrorist activities and potential environmental accidents (see Fig. 4). Extension of the system, to include the most recent version of ESRI's ArcView 9 GIS software, is in progress.

In October 2003 the US Coast Guard's (USCG) Headquarters, Washington, DC issued a contract to Applied Science Associates, Inc(ASA), Northrop Grumman Information Technology, and Metron Inc. to develop the Search and Rescue Optimal Planning System (SAROPS), the next generation of software, for search and rescue operations. The system will be national in scope and incorporate all U.S. coastal waters, plus the Great Lakes. SAROPS will include three main subsystems: ESRI ArcView GIS-based user interface, Environmental Data Retrieval System, and a Search Planning

Simulator. The system will allow the search planner to define the scenario; to access environmental data (winds and currents) necessary to compute drift paths, estimate effective sweep widths, and survival times; to simulate environmental hazards; and to develop near optimal search plans given the amount of searching effort available. In the first phase of the project the environmental data retrieval system will use predictions from the Navy's circulation and meteorological modeling systems. Future versions will link SAROPS to the emerging regional coastal ocean observing and forecasting systems being developed under the Ocean.US led IOOS program. The fundamental architecture for the environmental data retrieval and GIS based user interface components of the SAROPS are extensions of COASTMAP.

Anteon, University of Connecticut, and Applied Sciences Associates, Inc. (ASA) are in the process of submitting a proposal to the US Coast Guard to implement a linkage between the output of HF coastal ocean radar (CODAR) systems and SAROPS. The implementation will allow SAROPS to directly access coastal radar data or short-range forecasts of surface current fields using the University of Connecticut, Short Term Predictions System (STPS). STPS bases its predictions on the radar data. The linkage will be demonstrated and tested for CODAR systems currently operational in Block Island Sound and the Mid Atlantic Bight. ASA's focus in this project will be to enhance COASTMAP's ability to access CODAR data and forecast products and link those with the SAROPS environmental data retrieval system. The development of this linkage will allow SAROPS to access the data that is currently being collected by the rapidly evolving network of coastal HF radar systems.

The Naval Undersea Warfare Center (NUWC) located in Newport, RI has obtained a license to the COASTMAP system through one of its subcontractors. They are using COASTMAP to display real time measurements collected by an AUV equipped with a SubChem chemical sensing system. COASTMAP obtains real time data on the three dimensional location of the AUV and the concentrations of iron and nutrients measured by the on-board sensors. COASTMAP can then display plan, section, or three dimensional views of the data as it is collected. The data from each run of the AUV is stored and available for subsequent use.

The improvements of LAPS' surface analysis scheme resulting from this NOPP project have been incorporated in new versions of LAPS used by the NWS, U. S. Air Force, and by NOS for generating analyses over the Chesapeake Bay including the Washington, DC metro area. The gridded analyses for both Narragansett Bay and Chesapeake Bay were sent hourly to Defense Department's Defense Threat Reduction Agency for potential use in their air dispersion trajectory models in support of Homeland Defense.

Economic Development

The University of Rhode Island Ocean Engineering is currently working cooperatively with the RI Economic Development Corp (EDC) to establish a **RI Partnership for Maritime Security and Threat Response**. Additional partners include the Naval Underwater Warfare Center (NUWC), Raytheon, Purvis Systems, LiveWave, ASA, ProvPort (Duke Energy), KeySpan, L-3 Communications, and the RI Emergency Management Agency (RIEMA). The goal of the partnership is to develop a prototype port and harbor security system to address water borne threats made against the state's transportation and utility infrastructure, with specific emphasis on protecting dangerous cargo, such as transport of LNG/LPG through Narragansett Bay and its subsequent storage in the Port of Providence.

The major components of the integrated system include coastal surface and underwater surveillance and a crisis management and response system. As currently envisioned, COASTMAP will serve as the environmental data and information system and provide supporting data to the crisis management system. EDC is currently pursuing funding for this initiative from private industry, federal and state government appropriations, and State and Department of Homeland Security Grants.

Quality of Life

The Narragansett Bay Commission has obtained four licenses to COASTMAP. NBC oversees the operation of the largest wastewater treatment facilities in Narragansett Bay (and RI) and has a comprehensive network of real time monitoring stations that provide information on the system performance and the quality of the receiving water. COASTMAP is configured to collect data from a network of real time water quality monitoring systems (YSI/Endeco 6600 Sondes) distributed in the upper bay. In addition, links to the NOAA Narragansett Bay PORTS and the US Geological Survey real time stream gauging stations have been established. Public access to the data can be obtained through NBC's EMPACT web site.

If the LAPS analyses are found to be superior to present analyses used by NOS operational estuarine forecast models, then the LAPS will be made an operationally system at NOS. This could lead to improvement water level and current forecasts to support safe navigation, search and rescue, and HAZMAT response.

CONSIDERATION FOR EXCELLENCE IN PARTNERING AWARD

1. **Ocean Sector Diversity:** Three universities (URI, Drexel, Brown), two government agencies (NOAA/NOS, Navy) and one private firm (Applied Science Associates, Inc., ASA)
2. **Partner Involvement:** URI, Drexel, ASA and NOAA/NOS about equal share of funds. Navy no funding, Brown limited funding for two of the three years
3. **Matching Contributions:** State of RI funded PORTS system for Narragansett Bay (\$750K). Governor's Office funded real time monitoring system for Quonset Point (\$225K)
4. **Partner Long-Term Commitment:** The project team is currently leading an initiative to develop one of the regional systems within the Ocean.US coastal ocean observing system for US waters initiative.
5. **Success in Project Objectives:** The project team has completed all the project objectives established in our original proposal. The most important accomplishment is that the project has resulted in the development of one of the first truly globally re-locatable, integrated systems for real time observation, modeling, and data distribution for shelf, coastal sea, and estuarine waters. COASTMAP has been selected by NAVOCEAN to support their responsibilities for operational planning and action for special warfare, coastal insertion of ground forces, response to potential terrorist activities, and potential environmental accidents for US and international waters. COASTMAP will form one of the key components of the next generation of Search and Rescue Models (SAROPS) for the US Coast Guard. When fully operational the SAROPS environmental data server will provide current and wind fields for all coastal waters of the US, plus the Great Lakes. The initial system will access Navy model products, while the next generation will provide linkage to data and model products generated by the evolving coastal component of the Integrated Ocean Observing System (IOOS) and the associated network of coastal HF radar systems.

PUBLICATIONS

The publications section has been divided into news releases, TV specials/segments, presentations, reports and papers.

News releases

URI engineer develops system to map, monitor, forecast coastal conditions: Aids oil spill response, homeland security, search & rescue, more, University of Rhode Island, Communications Department, April 3, 2003.

URI to demonstrate COASTMAP April 22 System maps, monitors, forecasts coastal conditions Input sought from users of Narragansett Bay, University of Rhode Island, Communications Department, April 7, 2003.

TV Segments

Discoveries and Breakthroughs in Science (a part of the American Institute of Physics) prepared a short segment on COASTMAP and distributed it through their 80 TV station network around the country in July 2003.

The University of Rhode Island, Communications Department filmed a short interview with Malcolm Spaulding on the COASTMAP system. The segment aired on the University of Rhode Island's TV station during half time at a University of RI football game, November 2003.

Presentations:

Spaulding, M. L., 2003. COASTMAP: A globally re-locatable, real time, marine environmental monitoring and modeling system, with application to Narragansett Bay and southern New England coastal waters, Presentation at the New England Section, Marine Technology Society, April 24, 2003, University of Rhode Island, Coastal Institute, Narragansett, RI.

Spaulding, M. L. and Matt Ward, COASTMAP: A globally re-locatable, real time, marine environmental monitoring and modeling system, as a framework for a regional coastal ocean observing and forecasting system, Presentation at NOAA National Ocean Survey, Seminar Series, Silver Spring, MD, July 22, 2003.

Spaulding, M. L., 2003. COASTMAP A globally re-locatable marine environmental monitoring and modeling system: Crisis Management, IEEE Homeland Security Workshop, Warwick, RI, December 11, 2003.

Anderson, E., 2004. Synergies between IOOS and Oil Spill Modeling, AMS Interactive Symposium on Private Sector Opportunities in Operational Coastal Oceanography, Meteorology, and Hydrology, 84th Annual Meeting of the American Meteorological Society, Seattle, WA, January 7-15, 2004

Hartigan, P. and E. Howlett, 2004. Applied Science Associates Inc (USA) Operational Forecasting of Oil Spill Trajectories, Fates and Impacts using On-line Wind, Wave, Swell and Current Nowcasts, Fourth International Conference on Oil and Hydrocarbon Spills, Modeling, Analysis and Control, 28 - 30 April 2004, Alicante, Spain.

Ward, M.C., COASTMAP System Training, Naval Oceanographic Office, Stennis Space Center, MS, November 4-8, 2002 and February 24-28, 2003.

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Papers

A special session was organized at the 8th International Estuarine and Coastal Modeling (ECM8) Conference (Session 2A: Coastal Ocean Observing & Forecasting Systems-Narragansett Bay), Monterey, California, November 3-5, 2003 on the Narragansett Bay NOPP project. A list of the papers presented at the conference is provided below. These papers will be published in the refereed conference proceedings, scheduled to appear in July 2004.

Malcolm Spaulding

A globally re-locatable, real time, marine environmental monitoring and modeling system, with application to Narragansett Bay and southern New England coastal waters.

John G.W. Kelley

Evaluation of high-resolution atmospheric analyses and forecasts for the Narragansett Bay Region

Matthew Ward

Narragansett Bay forecasting system: forecasting skill assessment

Thomas Opishinski

An internet-based data acquisition and management server system

Michael Piasecki

A web-based dissemination system for now and forecast data products

Piasecki, M., Bermudez, L., Islam, S., Sellerhoff, F., “IM2: A Web-based Dissemination System for Now and Forecast Data Products”, 8th International Conference on Estuarine and Coastal Modeling, November 3-5, 2003, Monterey, CA

Howlett, E, E. Anderson, and C. Galagan, 2003. Real time marine emergency response tools, 2nd International Conference on Port and Maritime Research, Development, and Technology, Marine Pollution Agency, Singapore.

Kelley, J. G. W., M. Tsidulko, and M. Ward, 2003: Evaluation of high-resolution atmospheric analyses and forecasts for the Narragansett Bay. Proceedings, 15th International Conference on Estuarine and Coastal Modeling, Monterey, CA (in review).

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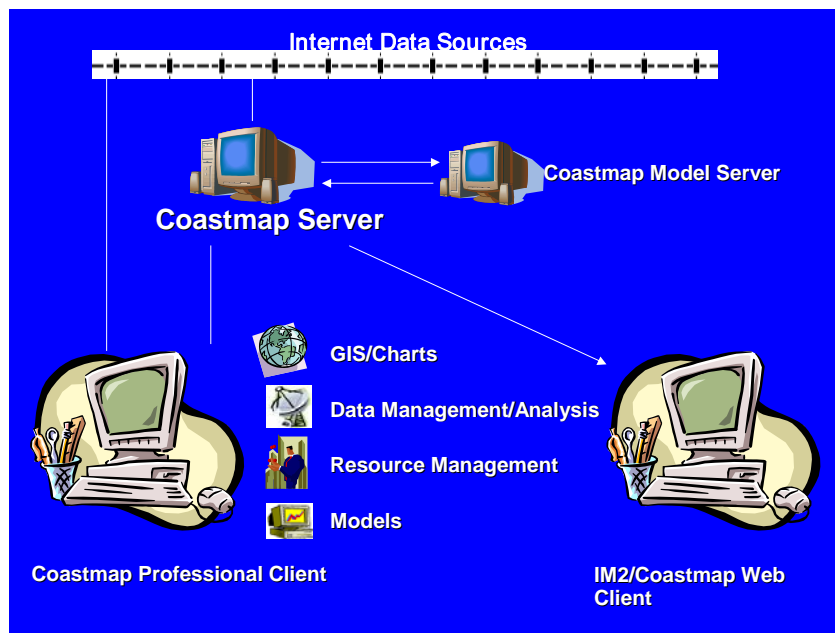


Figure 1 Operational schematic of COASTMAP

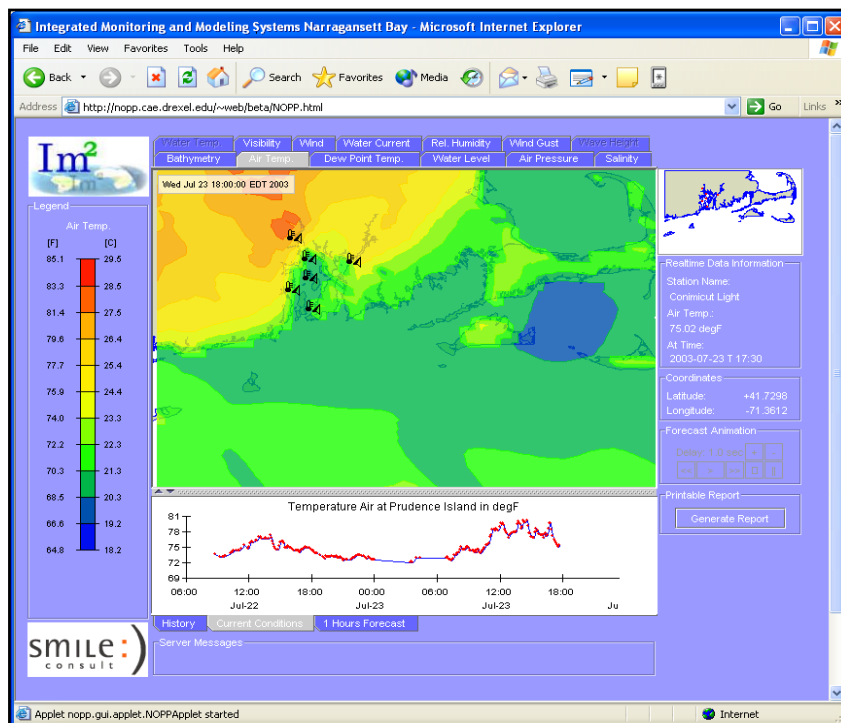


Figure 2 Area Contour and Station History Data for current Air Temperature Distribution

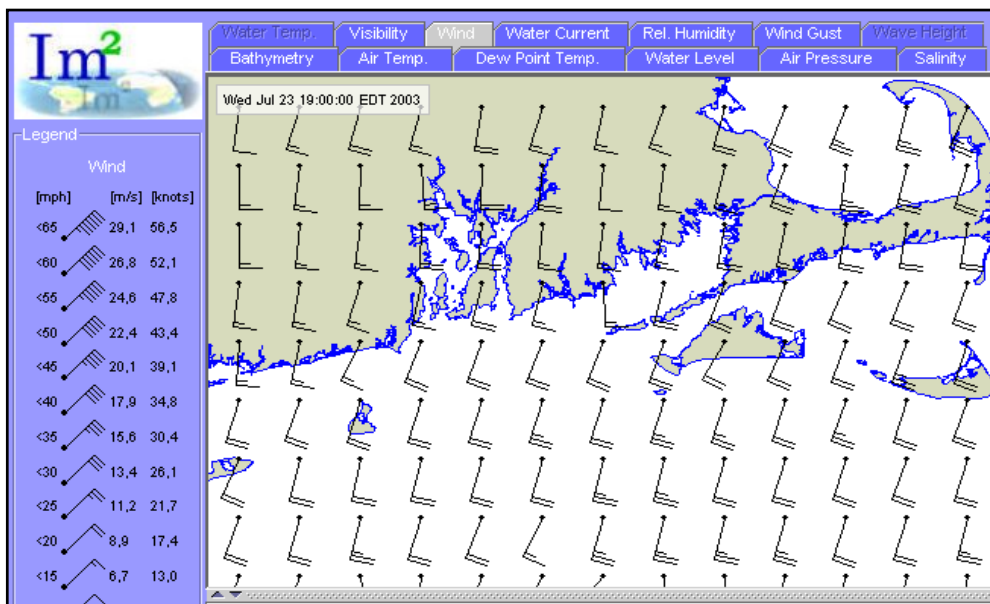
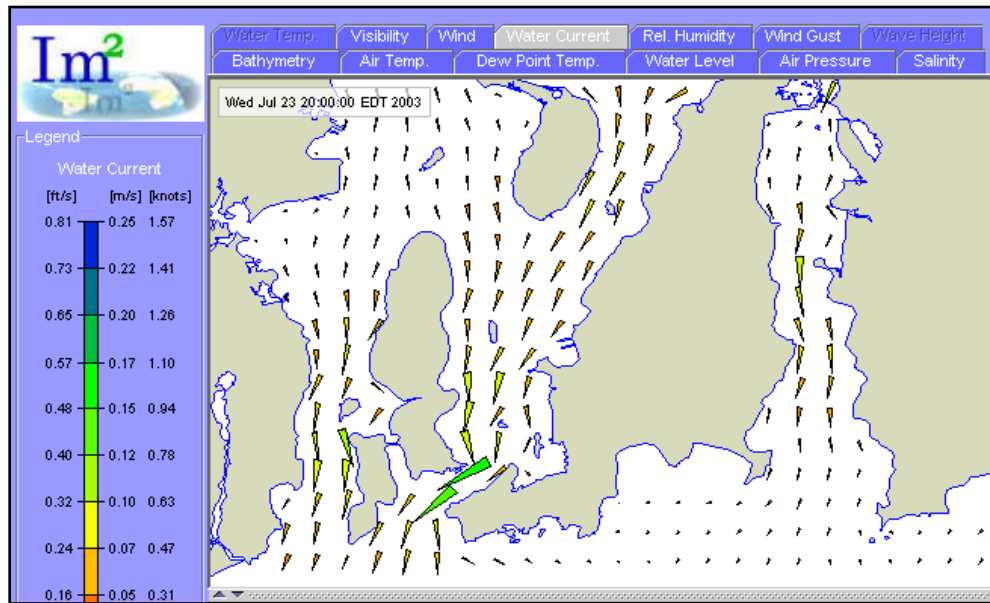


Figure 3 Surface Flow and Wind Field Plots

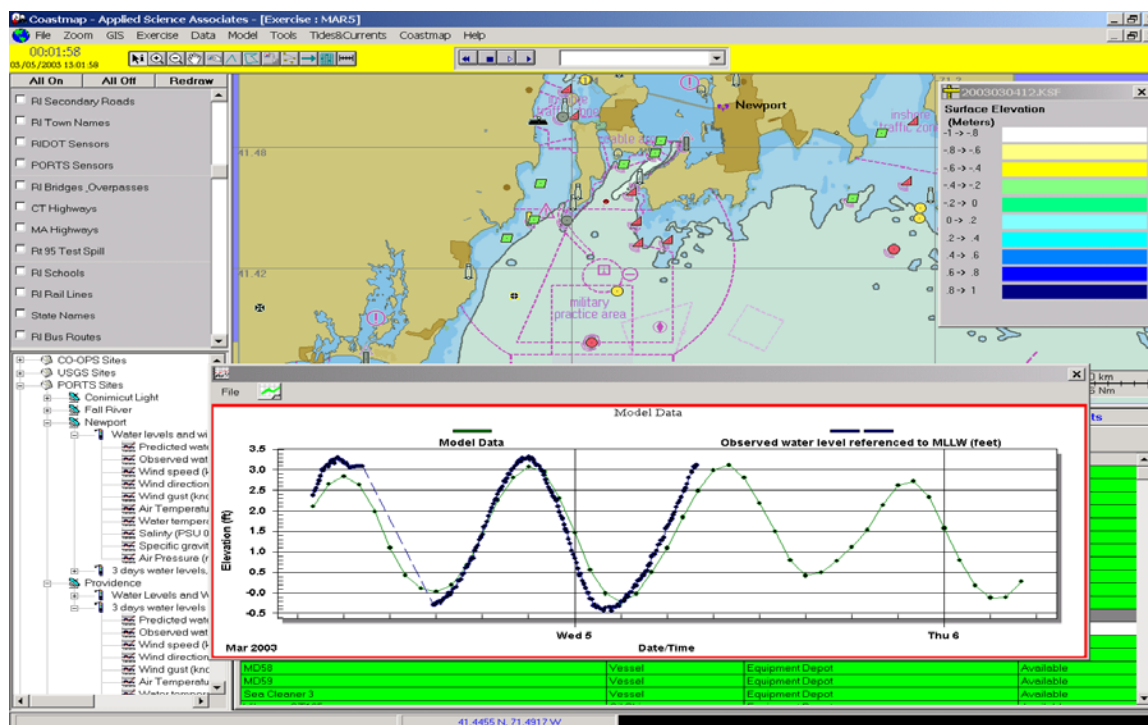


Figure 4 Output screen from COASTMAP showing a comparison between model predicted and observed water level at Newport, RI. Access to the GIS is the upper left and to real time data collection system in the lower left. A map of lower Narragansett Bay is in the background.